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Exhaust Gas Emission Characteristics of Rapeseed Oil fuelled Tractors

When using rape seed oil for fuel there are uncertainties about complying with exhaust gas emission regulations. Emission measurements from two rape seed oil fuelled tractors show that the Deutz-Fahr tractor meets the relevant exhaust gas stage II requirements for CO, hydrocarbons (HC) and particle mass, but not for NO_X. The Fendt tractor fulfilled its applicable exhaust gas stage I. Idle and low load operations with rapeseed oil fuel lead to higher particulate matter and CO emissions compared to diesel fuel, whereas during middle and heavy load operations, particle matter and CO-emissions are equal or lower. With all load stages NO_X emissions are a little higher and HC emissions are significantly lower with rapeseed oil fuel than with diesel fuel.

The use of rapeseed oil fuel in vegetable oil compatible tractors has environmental benefits and increases agricultural value-added. Additionally, a reduction of costs can be achieved in many cases. Uncertainties are the compliance with exhaust gas emission regulations. Thus, it is the purpose of this work, to investigate the emission characteristics of two rapeseed oil fuelled tractors in practical use by recurrent measurement.

Methodology

Objects of investigation are a Deutz-Fahr Agrotron TTV 1160 and a Fendt Farmer Vario 412 tractor. All limited exhaust gas components, as there are carbon monoxide (CO), nitrogen oxides (NO_X), hydrocarbons (HC) and particle matter, are recorded. Important data of the tractors are displayed in *Table 1*. The measurement takes place at the tractors with mounted engines according to EU-Directive 2000/25/EG. Thereby, eight test stages within the engine operating map are run through (*Fig. 1*). The results of every single test stage are added up with specified weighting factors.

Results

Deutz-Fahr Agrotron TTV 1160

The emission tests took place immediately before adaptation (240 operating hours) and after adaptation (265 operating hours). Prior to engine adaptation the limiting values of exhaust gas stage II are proven to be fulfilled with diesel fuel (*Fig. 2*). The demands on NO_X-emissions are hit accurately. By adaptation (among others modified injection nozzles) emission behaviour is changed significantly. With diesel fuel approximately 50 % higher particle matter and 4 % higher nitrogen oxides emissions are ascertained. Running on rapeseed oil, NO_X-emissions show a further increase, exceeding the limiting value at 14 %. However with rapeseed oil fuel, a reduction for particle matter emissions could be observed. HC-emissions are more than 60 % less with rapeseed oil fuel, compared to diesel fuel for both, prior and after adaptation.

Fendt Farmer Vario 412

The new tractor (exhaust gas stage I) was converted to rapeseed oil fuel operation in 2003 and achieved a total of some 2000 operating hours, when being measured first. Emission measurement before adaptation was not possible. Since adaptation, no modifications on the tractor took place. The fulfillment of exhaust gas stage I with rapeseed oil fuel could be verified (*Fig. 3*). With diesel fuel, the limiting value of CO was exceeded by 13 %. This might be due to a required exchange of the injection nozzles. NO_X-emissions were 13 % higher with rapeseed oil fuel, compared to diesel fuel. All other limited emission compounds showed major advantages with rapeseed oil fuel,

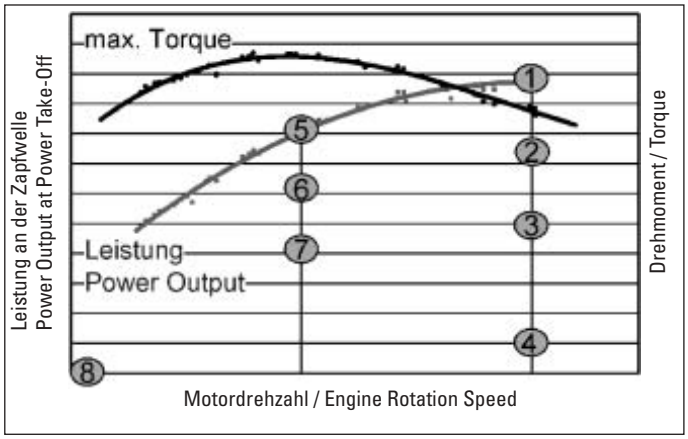

Fig. 1: Eight test stages within the Engine Operating Map according to EU directive 2000/25 for emission tests

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Keywords
Rapeseed oil fuel, tractors, exhaust gas emissions

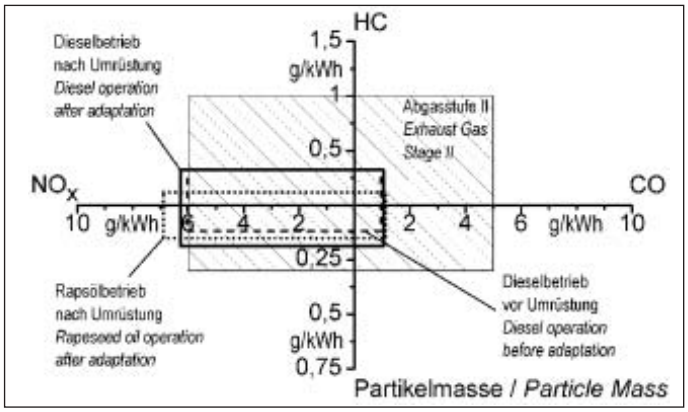

Fig. 2: Limited exhaust gas emissions of a Deutz-Fahr tractor (exhaust gas stage II) with Rapeseed Oil and Diesel Fuel

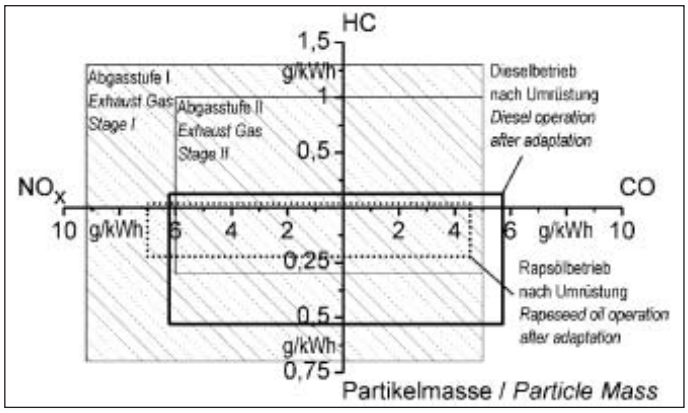

Fig. 3: Limited exhaust gas emissions of a Fendt tractor (exhaust gas stage I) with Rapeseed Oil and Diesel Fuel

leading for those to compliance with even exhaust gas stage II.

A detailed look at the emissions of both tractors reveals that idle and low load operation with rapeseed oil fuel leads to higher particle matter- and CO-emissions in comparison to diesel fuel, whereas during middle and heavy load operation particle mass and CO-emissions are equal or leower. For nitrogen oxides during all eight test stages of the engine operating map, emissions with rapeseed oil fuel are little higher than with diesel fuel, but on the other hand hydrocarbons are reduced significantly.

Conclusions and Outlook

By comparing emissions between diesel and rapeseed oil fuel operation, it has to be considered, that engines are usually optimized for either, rapeseed oil or diesel fuel. For the presently available rapeseed oil fuel compatible tractors an optimization regarding exhaust gas emissions is usually not carried out, thus indicating a high reduction potential. Nowadays activities of engine and agricultural machinery industry aiming on the development of rapeseed oil fuel compatible engines have been started. With fuel specific optimization of the engine and the engine operating map, the fulfillment of future emission requirements is feasible with both, diesel and rapeseed oil fuel. Within the research project further tests will be conducted, focussing also on "stage 3 tractors" and not limited emission compounds.

	Deutz-Fahr Agrotron TTV 1160	Fendt Farmer Vario 412
Number of Cylinders	6	4
Engine Power in kW / HP	119 / 162	94 / 125
Engine Type	Deutz BF6M1013EC	Deutz BF4M2013C
Year of Manufacture	2005	2003
Exhaust Gas Stage	II	I
Adaptation Company	Hausmann	VWP
Operating Hours at Adaptation	256	<50

Table 1: Technical features of the tested tractors

Literature

[1] - : Richtlinie 2000/25/EG des europäischen Parlaments und des Rates über Maßnahmen zur Bekämpfung der Emission gasförmiger Schadstoffe und luftverunreinigender Partikel aus Motoren, die für den Antrieb von land- und forstwirtschaftlichen Zugmaschinen bestimmt sind, und zur Änderung der Richtlinie 74/150/EWG. ABl. Nr. L 173 vom 12. 7. 2000, zuletzt geändert durch Richtlinie 2005/13/EG (ABl. Nr. L 55 v. 1. 3. 2005) der Kommission